4.0 SEGMENTATION DETERMINATION

This section details the procedure employed to assess both the existing segmentation in the Galveston Bay system and those segment boundaries proposed for inclusion in the final segmentation scheme.

4.1 Decision Matrix

Several segmentation schemes currently exist for Galveston Bay, particularly with respect to natural resources data. Both State and Federal natural resource agencies collect data for the management of resources within Galveston Bay. These segmentation schemes have evolved under differing criteria including monitoring designations, regulatory requirements, anthropogenic factors, natural resource distributions, and physical characteristics such as hydraulics. The focus of this project is to devise a segmentation scheme that accounts for as many of these needs and influences as possible while producing a manageable segmentation scheme.

To facilitate the conceptualization and visualization of the information employed in development of a segmentation scheme, a decision matrix was constructed. The decision matrix is basically a spreadsheet or ledger with rows comprised of the existing and proposed segments and boundaries. The columns in the matrix are the criteria for which the segments are evaluated. Ideally, the matrix would be based upon independent objective criteria which could be easily quantified. However, the characteristics traditionally measured and evaluated for a ecologically-complex living system such as an estuary are quite interrelated. As a result, the amount of correlation between the criteria in the decision matrix is considerable. For instance, the array of parameters measured to characterize water quality are to a large degree dependant upon other physical, anthropogenic, and hydrodynamic factors included in other criteria such as circulation patterns, bathymetry, and the quantity and quality of the waste loads to which the area is subject.

As a result, the decision matrix is largely qualitative in nature. Considerable effort was expended to score the matrix as objectively as possible. Much of the information synthesized for scoring each criteria is qualitative in nature and nonuniformly distributed in both time and space. As a result, some intuition was required in the scoring of the matrix. The effect of individual bias was minimized, to the extent possible, by employing a "committee" decision process for scoring the matrix among the members of the project team.

The decision matrix is shown in Table 4. The criteria employed in the matrix are discussed in sections 4.2.2 through 4.2.12 of this report. Except for a few exceptions discussed in the following section, most criteria were scored "H" for high, "M" for medium, and "L" for low indicating the positioning of particular areas along the gradient represented by a criterion relative to its potential impact upon segmentation.

4.2 Criteria

4.2.1 Simplicity

Obviously, any segmentation scheme that included boundaries to satisfy any and all conceivable criteria would result in a profusion of small segments. Management of the segment boundaries and their locations would be as big a difficulty as management of the estuary, a goal to which the segmentation scheme is intended to complement rather than confound. The criterion of simplicity is implicit in this analysis rather than explicit since this criterion applies across the segmentation scheme as a whole rather than to individual criteria. An effort was made to subdivide the system into as few segments as would adequately serve the purposes of this study and satisfy the criteria.

4.2.2 Jurisdictional and Administrative Boundaries

Within the criteria headings of the decision matrix, a distinction has been made between jurisdictional and administrative boundaries. Jurisdictional boundaries are defined as territorial limits that, at least approximately, define an entity's jurisdiction. Examples of jurisdictional boundaries are county boundaries and city limits (less the variable nature of

Table 4
Segmentation Decision Matrix

Segment or Boundary	Jusisdictional	Administrative	Physical Boundary	Ease of Location	Inflows	Channel	Current Pattern	Water Quality	Sediment Distribution	Biological	Anthropogenic Influence	Exceptional Resource
Upper Galveston Bay Area												
TWC 2421 Upper Galveston Bay		Y	M	M				M	M	H	M	
NMFS Area 3 Upper Galveston Bay		Y	M	M				M	M	H	M	
NMFS Area 3.1 SW Upper Galveston Bay		Y	L	L				M	L	M	M	
NMFS Area 3.2 W Upper Galveston Bay		Y	L	L				H	L	H	H	
NMFS Area 3.3 N Upper Galveston Bay		Y	M	L				H	L	H	H	
NMFS Area 3.4 SE Upper Galveston Bay		Y	L	L				M	M	M	M	
TDH Area 1 Conditionally Approved Area		Y	L	L				M	L	M	M	
TDH Galveston/Trinity Bay Closed Area		Y	L	L				M	L	H	M	
TDH Area 2 Conditionally Approved Area		Y	L	L				M	M	M	M	
UTCRWR Seg. G1			M	L				H	L	H	H	
UTCRWR Seg. G3			L	L				M	M	H	H	
UTCRWR Seg. G4			M	L				M	L	H	M	
UTCRWR Seg. G5			L	L				M	M	H	L	
UTCRWR Seg. G6			L	L	H				L		M	
UTCRWR Seg. G10			L	M				H	L	H	H	
UTCRWR Seg. G11			L	M				H	M	H	H	
UTCRWR Seg. G12			L	M				M	M	M	M	
UTCRWR Seg. G13			L	M				M	M	M	M	
UTCRWR Seg. G15			L	H		H		M	M	H	H	
UTCRWR Seg. G16			H	H		H		M	M	H	H	
UTCRWR Seg. G17			H	H		H		M	M	H	H	
UTCRWR Seg. G18			H	H		H		M	M	H	H	
UTCRWR Seg. G22			H	H				H	U	H	H	
UTCRWR Seg. G23			M	H				M	U	H	H	
UTCRWR Seg. G24			L	M				M	H	H	H	
UTCRWR Seg. G25			L	L				M	M	M	M	
UTCRWR Seg. G26			L	M				L	L	L	L	
Clear Lake Area												
TWC 2425 Clear Lake		Y	H	H				H	U	M	H	
UTCRWR Seg. C1			H	H				H		M	H	
UTCRWR Seg. C2			H	H				H	U	M	H	
UTCRWR Seg. C4			H	H				H		M	H	
UTCRWR Seg. C5			H	H				H	U	M	H	
TWC 1101 Clear Creek Tidal		Y	H	M				H		M	H	
Armand Bayou Area												
TWC 1113 Armand Bayou Tidal		Y	H	H				L		M	H	Y
UTCRWR Seg. C3			H	H				L		M	H	Y
Bayport Channel												
TWC 2438 Bayport Channel		Y	H	H		H	H	M		M	H	
UTCRWR Seg. G2			H	H		H	H	M		M	H	

Table 4 (cont.)
Segmentation Decision Matrix

Segment or Boundary	Jusisdictional	Administrative	Physical Boundary	Base of Location	Inflows	Channel	Current Pattern	Water Quality	Sediment Distribution	Biological	Anthropogenic Influence	Exceptional Resource
Trinity Bay Area												
TWC 2422 Trinity Bay		Y	H	H	H			M	M	H	H	
NMFS Area 2 Trinity Bay		Y	H	H	H			M	M	H	H	
NMFS Area 2.1 Lower Trinity Bay		Y	L	M	M			M	M	H	H	
NMFS Area 2.2 Central Trinity Bay		Y	L	L	H			M	M	H	H	
NMFS Area 2.3 Upper Trinity Bay		Y	M	M	H			H	M	H	H	
TDH Area 3 Conditionally Approved Area		Y	L	L				M	H	M	M	
UTCRWR Seg. T1			L	L	M			M	M	H	H	
UTCRWR Seg. T2			L	L	M			M	M	H	H	
UTCRWR Seg. T3			L	L	H			M	L	H	H	
UTCRWR Seg. T4			L	L	M			L	U	L	M	
UTCRWR Seg. T5			L	L	M			L	U	M	M	
UTCRWR Seg. T6			L	L	H			H	U	H	H	
UTCRWR Seg. T10			L	L	M			M	M	M	H	
UTCRWR Seg. T11			L	L	M			M	M	M	H	
UTCRWR Seg. T12			L	L	H			M	M	H	H	
UTCRWR Seg. T14			H	H	M	H		M	M	H	M	
UTCRWR Seg. T15			H	H	M	H		M	M	H	M	
UTCRWR Seg. T16			H	H	M	H		M	M	H	M	
Cedar Bayou Area												
TWC 0901 Cedar Bayou Tidal		Y	H	H	M			H		M	H	
UTCRWR Seg. C6			H	H	M			H		M	H	
Trinity River												
TWC 0801 Trinity River Tidal		Y	H	H	H			H		H	H	
UTCRWR Seg. T7			H	L	H			H		H	H	
UTCRWR Seg. T8			H	M	H			H		H	H	
UTCRWR Seg. T9			H	H	H			H		H	H	
UTCRWR Seg. T13			H	L	H			H		H	H	
Double Bayou Area												
UTCRWR Seg. T17			H	H								
UTCRWR Seg. T18			H	M								
UTCRWR Seg. T19			H	M								

Table 4 (cont.)
Segmentation Decision Matrix

Segment or Boundary	Jusisdictional	Administrative	Physical Boundary	Ease of Location	Inflows	Channel	Current Pattern	Water Quality	Sediment Distribution	Biological	Anthropogenic Influence	Exceptional Resource
West Bay Area												
TWC 2424 West Bay		Y	H	H				M	L	H	M	
NMFS Area 1 West Bay		Y	H	H				M	L	H	M	
NMFS Area 1.1 Southeastern West Bay		Y	L	L				M	L	H	M	
NMFS Area 1.2 Northeastern West Bay		Y	L	L				M	L	H	H	
NMFS Area 1.3 East Central West Bay		Y	M	L				L	M	L	L	
NMFS Area 1.4 Central West Bay		Y	M	L				L	M	L	L	
NMFS Area 1.5 Western West Bay, Christmas Bay & Drum Bay		Y	M	H				L	M	L	L	
TDH Eastern West Bay Closed Area		Y	M	H				H	L	H	H	
UTCRWR Seg. W4			M	M				L	M	L	L	
UTCRWR Seg. W5			L	L				M	M	M	M	
UTCRWR Seg. W9			M	L				L	M	L	L	
UTCRWR Seg. W10			M	M				L	M	L	L	
UTCRWR Seg. W11			M	M				M	M	L	M	
UTCRWR Seg. W12			H	L				M		H	H	
UTCRWR Seg. W13			M	H				M	H	H	H	
UTCRWR Seg. W14			H	H				M	U	H	H	
UTCRWR Seg. W15			M	M		M		M	L	H	H	
Chocolate Bay Area												
TWC 2432 Chocolate Bay		Y	H	H			H	M	L	H	H	
NMFS Area 1.6 Chocolate Bay		Y	H	H			H	M	L	H	H	
TDH Chocolate Bay Closed Area		Y	H	H			H	M	L	H	H	
UTCRWR Seg. W6			M	H		H	H	M	M	H	H	
UTCRWR Seg. W7			H	H			H	M	L	H	H	
TWC 1107 Chocolate Bayou Tidal		Y	H	H				M		M	H	
UTCRWR Seg. W8			H	H				M		M	H	
Bastrop Bay/Oyster Lk.												
TWC 2433 Bastrop Bay/Oyster Lake		Y	H	H			H	L	H	L	L	
UTCRWR Seg. W2			H	H			H	L	H	L	L	
TWC 1105 Bastrop Bayou Tidal		Y	H	M				H		H	H	
UTCRWR Seg. W3			H	M				H		H	H	
Christmas Bay Area												
TWC 2434 Christmas Bay		Y	H	H			H	L	H	L	L	Y
UTCRWR Seg. W1			H	H			H	L	H	L	L	Y
Drum Bay Area												
TWC 2435 Drum Bay		Y	H	H				L	U	L	L	E

Table 4 (cont.)
Segmentation Decision Matrix

Segment or Boundary	Jusisdictional	Administrative	Physical Boundary	Ease of Location	Inflows	Channel	Current Pattern	Water Quality	Sediment Distribution	Biological	Anthropogenic Influence	Exceptional Resource
Lower Galveston Bay Area												
TWC 2439 Lower Galveston Bay		Y	M	M				M	L	H	H	
NMFS Area 5 Lower Galveston Bay		Y	M	M				M	L	H	H	
NMFS Area 5.1 SW Lower Galveston Bay		Y	H	H				M	L	H	H	
NMFS Area 5.2 W Lower Galveston Bay		Y	M	M				M	L	L	L	
NMFS Area 5.3 NW Lower Galveston Bay		Y	L	L				M	L	H	H	
NMFS Area 5.4 E Lower Galveston Bay		Y	L	L				M	L	L	L	
NMFS Area 5.5 Bolivar Roads		Y	M	M								
UTCRWR Seg. G7			L	M				M	L	H	H	
UTCRWR Seg. G8			L	M				M	M	H	H	
UTCRWR Seg. G9			M	M				M	L	L	L	
UTCRWR Seg. G14			L	M				M	L	H	H	
UTCRWR Seg. G19			L	H		H		M	M	M	H	
UTCRWR Seg. G20			L	H		H		M	M	M	H	
UTCRWR Seg. G21			L	H		H		M	M	M	H	
UTCRWR Seg. G27			L	L		M		M	L	L	L	
UTCRWR Seg. G28			L	L				M	L	L	L	
UTCRWR Seg. G29			L	L				M	L	L	L	
UTCRWR Seg. G30			L	L		M		M	L	M	M	
UTCRWR Seg. G31			L	L				M	L	L	L	
UTCRWR Seg. G32			L	L				M	L	L	L	
UTCRWR Seg. G33			H	H		H	H	M	M	M	M	
UTCRWR Seg. G34			H	H		M		M	L	H	H	
UTCRWR Seg. G37			H	H		H	H	M	M	H	H	
UTCRWR Seg. G38			H	H		H	H	M	M	H	H	
UTCRWR Seg. W16			M	M		M	H	M	L	H	H	
UTCRWR Seg. W17			M	M			H	M	L	H	H	
UTCRWR Seg. W18			M	H				M	H	H	H	
UTCRWR Seg. W19			H	H		H	H	M	H	H	H	
Dickinson Bay Area												
TWC 1103 Dickinson Bayou Tidal		Y	H	M				H		H	H	
UTCRWR Seg. D1			H	M				H		H	H	
UTCRWR Seg. D2			H	H			H	M	U	H	H	
UTCRWR Seg. D3			H	H			H	M	U	H	H	
Moses Lk./Dollar Bay												
TWC 2431 Moses Lake		Y	H	H			L	M	L	H	H	
UTCRWR Seg. D4			H	H			H	M	U	H	H	
UTCRWR Seg. D5			H	H			H	M	H	H	H	
Texas City Ship Channel												
TWC 2437 Texas City Ship Channel		Y	H	H		H		M		H	H	

Table 4 (cont.)
Segmentation Decision Matrix

Segment or Boundary	Jusisdictional	Administrative	Physical Boundary	Ease of Location	Inflows	Channel	Current Pattern	Water Quality	Sediment Distribution	Biological	Anthropogenic Influence	Exceptional Resource
Houston Ship Channel/ San Jacinto River Area												
TWC 1001 San Jacinto River Tidal		Y	H	M				H		H	H	
UTCRWR Seg. S1			H	M				H		H	H	
UTCRWR Seg. S2			H	H		M		H		H	H	
TWC 1005 Houston Ship Channel/ San Jacinto River		Y	H	H		H		H	M	H	V	
UTCRWR Seg. H1			H	H		H		H	M	H	V	
UTCRWR Seg. H7			H	H		H		H	M	H	V	
UTCRWR Seg. H11			H	H		H		H	M	H	V	
UTCRWR Seg. H12			H	H		H		H	M	H	V	
TWC 1006 Houston Ship Channel		Y	H	H		H		H	M	H	V	
UTCRWR Seg. H13			H	H		H		H	M	H	V	
UTCRWR Seg. H14			H	H		H		H	M	H	V	
UTCRWR Seg. H15			H	H		H		H	M	H	V	
TWC 1007 Houston Ship Channel/ Buffalo Bayou		Y	H	H		H		H	M	H	V	
UTCRWR Seg. H16			H	H		H		H	M	H	V	
UTCRWR Seg. H17			H	H		H		H	M	H	V	
UTCRWR Seg. H18			H	H		H		H	M	H	V	
UTCRWR Seg. H19			H	H		H		H	M	H	V	
UTCRWR Seg. H20			H	H				H		H	V	
Tabbs Bay												
TWC 2426 Tabbs Bay		Y	M	M				M	L	M	H	
UTCRWR Seg. H3			H	H				M	L	M	H	
San Jacinto Bay												
TWC 2427 San Jacinto Bay		Y	H	H				M	U	M	H	
UTCRWR Seg. H5			H	H				M		M	H	
UTCRWR Seg. H6			H	H				M		M	H	
Black Duck Bay												
TWC 2428 Black Duck Bay		Y	H	H				M		M	M	
UTCRWR Seg. H4			H	H				M		M	M	
Scott Bay												
TWC 2429 Scott Bay		Y	H	H				M		M	M	
UTCRWR Seg. H8			H	H				M		M	M	
Burnett Bay												
TWC 2430 Burnett Bay		Y	H	H				M		M	M	
UTCRWR Seg. H9			H	H				M		M	M	
Barbors Cut												
TWC 2436 Barbors Cut		Y	H	H				M	U	M	M	
UTCRWR Seg. H2			H	H				M	U	M	M	

Table 4 (cont.)
Segmentation Decision Matrix

Segment or Boundary	Jusisdictional	Administrative	Physical Boundary	Ease of Location	Inflows	Channel	Current Pattern	Water Quality	Sediment Distribution	Biological	Anthropogenic Influence	Exceptional Resource
East Bay Area												
TWC 2423 East Bay		Y	H	H			H	L	M	M	M	
NMFS Area 4 East Bay		Y	H	H			H	L	M	M	M	
NMFS Area 4.1 Lower East Bay		Y	M	M				L	M	L	M	
NMFS Area 4.2 Upper East Bay		Y	M	M				M	L	H	H	
TDH Eastern East Bay Closed Area		Y	M	H				H	L	H	H	
UTCRWR Seg. E1			M	M				L	M	L	M	
UTCRWR Seg. E2			M	M				L	M	L	M	
UTCRWR Seg. E3			M	M				L	M	L	M	
UTCRWR Seg. E4			M	M				M	L	H	H	
UTCRWR Seg. E5			M	M		M		M	L	H	H	
UTCRWR Seg. E6			M	M				M	L	H	H	
UTCRWR Seg. E7			H	H								
UTCRWR Seg. E8			H	H								
UTCRWR Seg. E9			H	H		H		M		M	H	
UTCRWR Seg. E10			H	H		H		M		M	H	
Boundaries												
Texas General Land Office State Land Tract System		Y										
Harris/Chambers County Galveston Bay/Tabbs Bay	Y											
Harris/Chambers County Galveston Bay/HSC	Y											
Harris/Galveston County Clear Lake	Y											
Galveston/Chambers County Upper/Lower Galveston Bay	Y											
Brazoria/Galveston County Western West Bay	Y											
City of Houston HSC/San Jacinto River	Y											
City of Baytown Goose Creek/HSC	Y											
City of La Porte Lower San Jacinto Bay	Y											
City of La Porte Upper San Jacinto Bay	Y											
City of La Porte Santa Anna Bayou	Y											
City of Shoreacres Galveston Bay	Y											
City of Seabrook Galveston Bay	Y											
City of Seabrook Clear Lake	Y											
City of Seabrook Taylor Lake	Y											
City of Pasadena Armand Bayou	Y											
City of Nassau Bay Clear Lake	Y											
City of League City Clear Lake	Y											

Table 4 (cont.)
Segmentation Decision Matrix

Segment or Boundary	Jusisdictional	Administrative	Physical Boundary	Ease of Location	Inflows	Channel	Current Pattern	Water Quality	Sediment Distribution	Biological	Anthropogenic Influence	Exceptional Resource
City of Clear Lake Shores Clear Lake	Y											
City of Texas City Galveston Bay	Y											
City of Texas City Dickinson Bayou	Y											
City of Texas City Dickinson Bay	Y											
City of Texas City Moses Lake & Dollar Bay	Y											
City of Texas City Texas City Ship Channel	Y											
City of Texas City Texas City Dike	Y											
Village of Tiki Island Jones Bay	Y											
Village of Tiki Island West Bay	Y											
City of Jamaica Beach West Bay	Y											
City of Galveston Galveston Bay	Y											
City of Galveston West Bay	Y											
City of Galveston Bolivar Roads	Y											
City of Galveston Gulf of Mexico	Y											
Texas City Dike			H	H			H					
Hanna Reef			H	M			H					
Shear Boundary along HSC			L	L			H					
Carancahua Reef			H	M			H					

extraterritorial jurisdiction). Administrative boundaries are boundaries separating subareas within an entities jurisdiction. Most of the existing segmentation encompass this function as one criterion.

4.2.3 Physical Boundaries

In terms of estuary segmentation, physical boundaries are usually shorelines or the mean high tidal limit. Since water is a fluid medium, one of the major constraints to fluid movement and circulation patterns are physical or morphological boundaries. Emphasis was placed upon defining segments, where possible, that were at least partially determined by physical boundaries.

Included as physical boundaries are geographic features such as shorelines, points, promontories, peninsulas, dikes, seawalls, breakwaters, and islands. Also included are hydrographic boundaries such as reefs and shoals. While not absolute barriers to hydraulic transport, their influence in determining circulation patterns and, concomitantly, other chemical and biological characteristics of an area is considerable.

In the context of this study, the Texas City Dike is an excellent example of a geographic boundary that greatly influences the circulation patterns in the area. Carancahua Reef is an equally good example of a hydrographic boundary that splits West Bay into two circulation cells. The cell on the west side of the reef is predominated by circulation from San Luis Pass while the circulation cell on the east side of the reef is predominated by Galveston Bay and Bolivar Roads circulation.

4.2.4 Ease of Location

Boundaries should be determinable in the field to be of maximum utility for monitoring or regulation. In segmenting an estuary the size of the Galveston Bay system, it is inevitable that some boundaries must cross expanses of open water. Preference was given to boundaries and potential boundaries that were definable from discernable landforms or landmarks.

areas adjacent. Despite it's variable nature, water quality is one of the most important criteria for segmentation, since water quality is one of the features estuarine management is intended to protect.

4.2.9 Sediment Distribution

Sediment distribution patterns are a valuable characteristic to be considered in a segmentation scheme for an estuary. Substrate characteristics play an important role in determining species distributions for benthic organisms and, to some extent, their demersal predators. Sediment distributions are reflective of many other characteristics of an area in an estuary including circulation patterns, bathymetry, turbulence and wave action, inflow characteristics, and surrounding land types and uses. Relative to characteristics of the water column, they are less dynamic. Sediment quality has been related to historical changes over many centuries.

Sediment distribution and uniformity was assessed for each existing and proposed segment. Preference was given for segments that exhibit a higher degree of sediment uniformity or a sediment distribution differing from its neighbor. The scoring in the matrix was based upon the following:

U - total uniform sediment distribution
H - high uniformity sediment distribution
M - medium uniformity sediment distribution
L - low uniformity sediment distribution.

4.2.10 Biological

The biological criterion in the decision matrix is a compendium of biological information available from a number of sources. The criterion reflects an assessment of reported biological problems in the area such as fish kills, TDH closed areas, TWC aquatic life uses, and, where available, species assemblage data. As such, it represents an admittedly crude biological risk assessment based upon available information. The criterion was scored high, medium, and low. As an example, areas that reported by TWC as not meeting "fishable" criteria were automatically scored high.

4.2.11 Anthropogenic Influence

This criterion is a qualitative assessment of human-induced input to the area. The bulk of the information utilized was from the TWC records and documents pertaining to point and non-point sources in the area. In addition, on-shore population density and land uses, dredge spoil locations, channelization and ship traffic, and locations of oil production areas were considered. The criteria was scored high, medium, and low as were most other criteria with the addition of "V" for areas of very high impact.

4.2.12 Exceptional Resource

This criterion was included to account for areas that have been designated as coastal preserves or that exhibit characteristics that, due largely to their relatively unimpacted state, may exhibit exceptional aquatic life uses or be potential coastal preserves. The criteria was scored with a "Y" for areas that are coastal preserves and "E" for areas of apparent exceptional resource value.

4.3 Proposed Segmentation

Of the existing segmentation schemes reviewed, the TWC scheme and the CRWR scheme, which was a hydrographic subdivision of the TWC scheme satisfied the criteria the best. This is not particularly surprising, since the TWC segmentation scheme encompasses a number of criteria and uses including administrative and monitoring. The TWC segmentation scheme subdivides the study area for this project into 29 segments as shown in Figures 3 and 4. The results of this study subdivide the area into 44 segments described subsequently. The resulting segmentation is shown on Figures 28 and 29.

4.3.1 Lower Galveston Bay Area

As indicated in Figure 28, the lower Galveston Bay area was subdivided into four segments labeled LG1 through LG4. The most prominent change was the designation of LG3. The LG3 segment is a one kilometer wide segment that encloses the Houston Ship Channel as it passes

through lower Galveston Bay. There are several prominent reasons this segment was designated. The comparatively deep Houston Ship Channel is a flow conduit in Galveston Bay and influences circulation and salinity patterns. Inspection of Figure 10 from the TWDB reveals that modeling predicts a shear boundary that coincides with the Houston Ship Channel and divides the Bay into sections of average inflow velocities and average outflow velocities driven by the Coriolis effect in the Bay. In addition, the area is one with high anthropogenic influence from shipping, dredging, and outflow from the heavily impacted upper Channel.

Segments LG1 and LG2 lie to either side of segment LG3. There are significant differences between LG1 and LG2, mostly due to human impact. LG1 is part of the area in Lower Galveston Bay that is closed to oystering by the TDH, whereas LG2 is predominantly open to oystering. LG1 receives more direct industrial impact from onshore land uses than does LG2. In addition, LG2 is adjacent to the Abshier wildlife management area.

The northern boundaries of segments LG1, LG2, and LG3 were established to coincide with the TWC boundary between upper and lower Galveston Bays. This boundary location can be justified for several reasons including salinity pattern variations modeled by the TDWR described in section 3.5.2, and a jurisdictional boundary defined by the chambers and Galveston County lines. The NMFS established a boundary here used to report commercial fishery statistics prior to 1976 (Section 3.10).

Segment LG4 encompasses Bolivar Roads, an area of relatively high tidal velocities and direct marine influence. Pelican Island and the Port Bolivar Peninsula create a hydrographic barrier between segment LG4 and the remainder of the lower Glaveston Bay segments. Figure 28 also indicates that the area to the west of the Texas City Dike was included in West Bay rather than Galveston Bay. From a hydrographic standpoint, the area is more related to West Bay than Galveston Bay due to the placement of the manmade barrier of the Texas City Dike.

4.3.2 Upper Galveston Bay Area

The upper Galveston Bay area was segmented into six segments. Segments UG3 and UG6 encompass the Houston Ship Channel and were created for the same reasons as LG3 described

previously. The segment boundary between UG3 and UG6 (as well as between UG6 and LG3) was established to take into account any water quality or biological differences that might be invoked due to it's proximity to adjacent segments. Segments UG1 and UG2 were divided from the body of upper Galveston Bay largely because they receive direct inflow from the upper reaches of the Houston Ship Channel. They were divided from each other along Atkinson Island which forms a partial hydraulic barrier. Dredge spoil piles along the eastern edge of segment UG3 enhance the barrier between the Houston Ship Channel and segment UG2.

Segments UG4 and UG5 are divided by the Houston Ship Channel segment UG6. Segment UG4 is either closed or only conditionally approved for shellfish harvesting by the TDH. The adjacent shore of segment UG4 is highly populated and developed. Segment UG5 has virtually no shoreline and is influenced heavily by its connection to Trinity Bay. The eastern boundary of segment UG5 corresponds to that established by the TWC. It's position can be based partially on salinity patterns predicted through modeling as described in Section 3.5.3 This boundary also matches one of several established by the Center for Research in Water Resources (CRWR) for the purpose of tracking typical plumes of run-off from the Trinity River described in more detail in Ward, 1991.

4.3.3 Trinity Bay Area

The TWC segmentation scheme includes Trinity Bay as a single segment. Trinity Bay has been divided into three segments along the inflow gradient of the Trinity River. The various inflow studies from the TWDB indicate the Trinity River inflow as the predominant freshwater inflow to the Galveston Bay system. Both NMFS and CRWR have divided Trinity Bay into approximately the same segments. The boundary between TB1 and TB2 coincides with the boundaries between the GLO land tracts, 51/50, 52/49, 53/48, 54/47, 55/46, 56/45, 57/44, 58/43, 59/42, and 60/41 in Trinity Bay. The boundary between TB2 and TB3 coincides with the boundaries between the GLO land tracts, 18-19D/22-23C, 18-19C/22-23C, 18-19B/22-23B, 18-19A/22-23A, 17-20A/21A, 20B/21B, 20C/21C, and the northeastern border of 20D in Trinity Bay. In addition, the TWC definition of the Trinity River tidal segment from its confluence with Trinity Bay to the tidal limit was preserved and is identified in Figure 28 as TR1. The western boundary of segment TB1 was established for salinity and run-off plume modeling as sited in

previous Section 4.3.2. Each of the transverse boundaries chosen for Trinity Bay approximate those used by the CRWR for plume modeling.

4.3.4 East Bay

The TWC segmentation includes East Bay as a single segment. East Bay was divided into two segments EB1 and EB2 along the boundary of the TDH closed area. Consideration was given to redefining the border between East Bay and lower Galveston Bay (segments EB1 and LG2) along Hanna Reef. Hanna Reef, as a hydrographic feature, directs flow into and out of East Bay. However, the existing TWC boundary was relocated in the past to account for the influence of Hanna Reef, and parts of the proposed segment boundary would have been difficult to locate in the field. The TWC segment 2423 encompassing East Bay was preserved as segment EB1.

4.3.5 West Bay

Probably the most significant changes in segmentation were made to West Bay. The area encompassed by segment WB1 was previously part of lower Galveston Bay in the TWC segmentation scheme. The partial occlusion of the inter-bay circulation patterns by Pelican Island and the Texas City Dike make this area hydraulically more related to West Bay than Galveston Bay. The boundary between WB1 and WB2 was originally intended to be the IH 45 Causeway. However, the boundary was relocated to the Deer Island/Tiki Island area at the suggestion of TWC staff that have many years experience in sampling and monitoring the area. (Kirkpatrick, 1991, personal communication) The Deer Island/Tiki Island area is shallower, has many small islands and spoil banks, and is probably more of a hydraulic constraint than the causeway.

West Bay was divided approximately in half along Carancahua Reef (or Caranachua Reef) since it forms a predominant hydraulic boundary. Segment WB3 encompasses the western end of West Bay to the west of Carancahua Reef. The TWC boundaries for Christmas Bay, Drum Bay, Bastrop Bay, and Chocolate Bays were preserved and are identified in Figure 28 as WB4, WB5, WB6, and WB7, respectively.

4.3.6 Moses Lake/Dollar Bay Area

TWC Segment 2431 that includes Moses Lake and Dollar Bay was preserved as segment ML1 as shown in Figure 28.

4.3.7 Clear Lake Area

TWC Segments 2425 (Clear Lake), 1101 (Clear Creek), and 1113 (Armand Bayou), contained in the Clear Lake watershed were preserved as segments CL1, CL2, and CL3, respectively. These are shown in Figure 28.

4.3.8 Tidal Bastrop Bayou and Chocolate Bayou

The two tidal TWC segments, Bastrop Bayou (Segment 1105) and Chocolate Bayou (Segment 1107), were preserved and identified in Figure 28 as BB1 and CB1, respectively. Bastrop Bayou enters Bastrop Bay and Chocolate Bayou enters Chocolate Bayou.

4.3.9 Houston Ship Channel Area

The three TWC segments (1005,1006, and 1007) that comprise the upper Houston Ship Channel were preserved and are identified in Figure 29 as HC1, HC2, and HC3, respectively. The San Jacinto River tidal segment from immediately below IH 10 in Harris County to the tidal limit was maintained and is indicated in Figure 29 as SJ1.

As indicated in Figure 29, most of segments enclosing the lateral bays along the Houston Ship Channel have been preserved. The exception is the addition of LB7 which contains Old River. This segment was included since it forms an alternate hydraulic channel between two other segments, HC1 and HC2.

4.3.10 Texas City Ship Channel

The TWC segment 2437 was preserved and identified in Figure 28 as TC1.

4.3.11 Dickinson Bay/Dickinson Bayou

Dickinson Bay, included in TWC Lower Galveston Bay segment 2439 was delineated as a separate segment DB1 due to a salinity gradient predicted by modeling (TDWR 1981). In addition, a hydrographic barrier is created by oyster reefs as shown in Figure 5.

The TWC segment 1103 which identifies the tidal portion of Dickinson Bayou was preserved as segment DB2.

4.3.12 Bayport Channel (Tidal)

The TWC segment 2438 was preserved as segment BC1.

4.3.13 Cedar Bayou (Tidal)

The TWC segment 0901 was preserved as segment CD1.

4.3.14 Intracoastal Waterway

The approximately 18 mile section of the Intracoastal Waterway passing through the Bolivar Peninsula has been added as segment IW1. The isolated character of this waterbody would create water quality and biological variations that are distinct from the other portions of the bay.

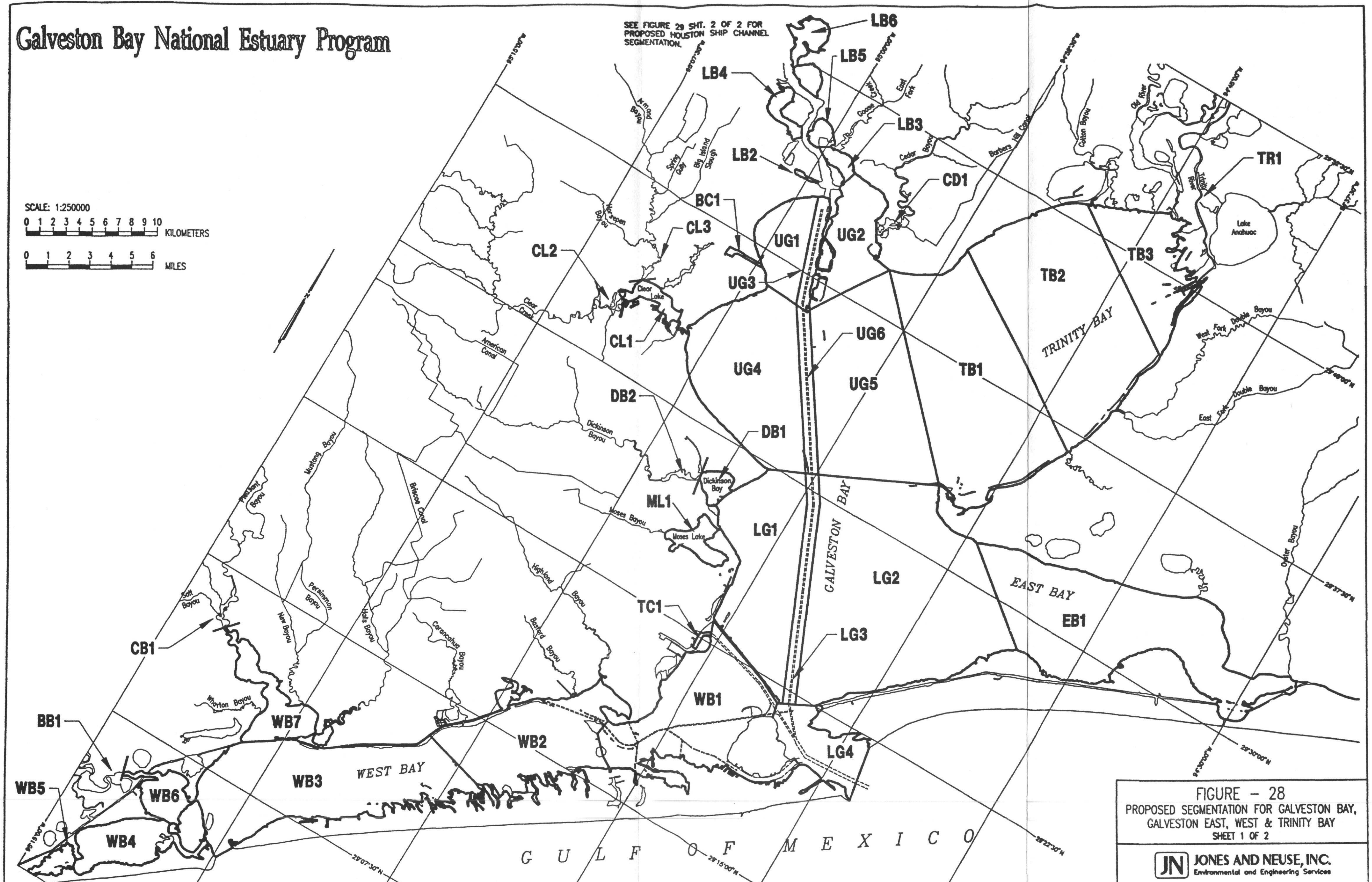
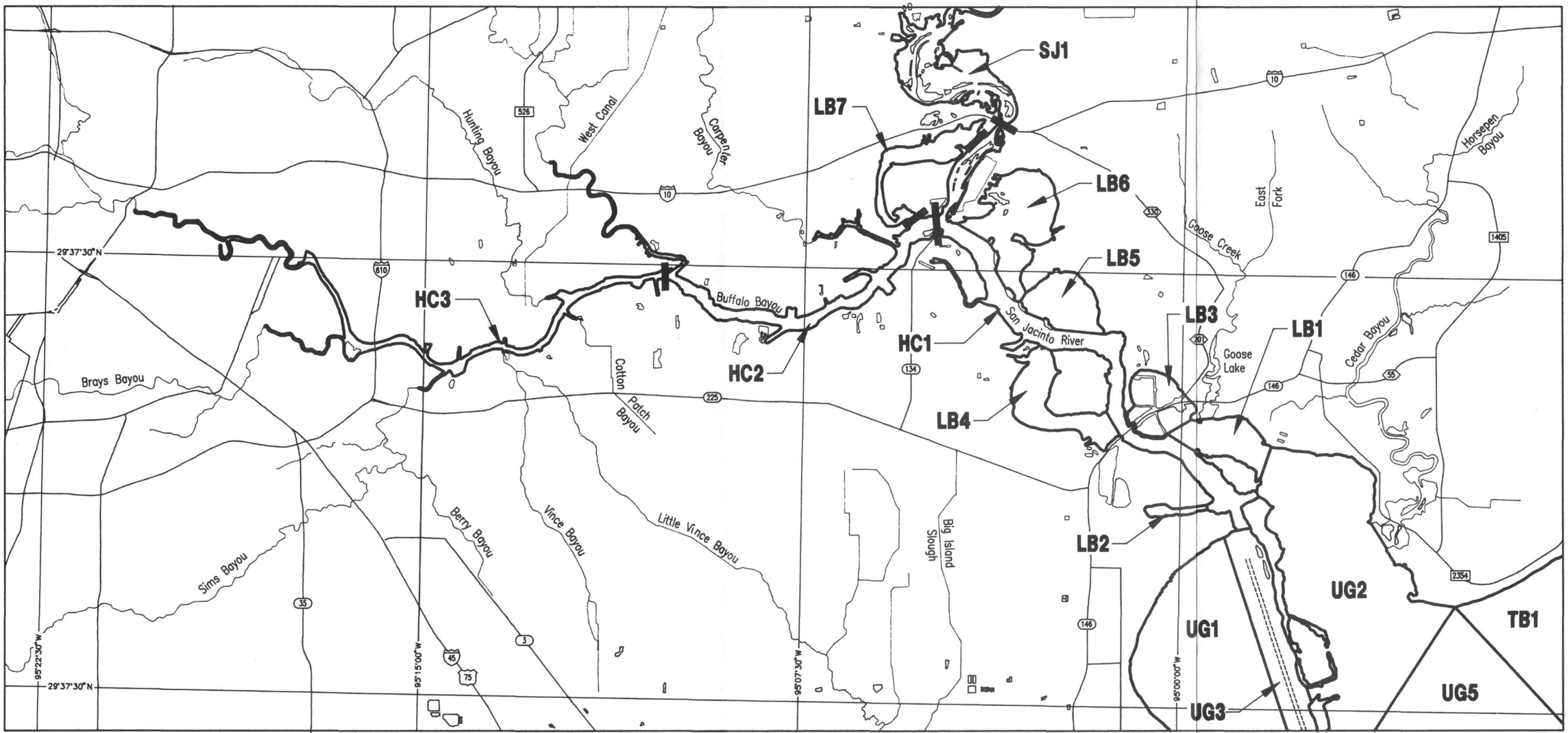


FIGURE - 28
PROPOSED SEGMENTATION FOR GALVESTON BAY, GALVESTON EAST, WEST & TRINITY BAY
SHEET 1 OF 2

Galveston Bay National Estuary Program

SEE FIGURE 28 SHT. 1 OF 2 FOR
GALVESTON BAY AREA SEGMENTATION.



SCALE: 1:126720

0 1 2 3 4 5 6 7 KILOMETERS

0 1 2 3 4 MILES

FIGURE – 29
PROPOSED SEGMENTATION
HOUSTON SHIP CHANNEL
SHEET 2 OF 2

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